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Aflatoxin Fact Sheet *

I. Introduction

Aflatoxins are a small group of mycotoxins produced by the fungi from the genus, ***Aspergillus.*** Aspergillus flavus and Aspergillus parasiticus produces a natural occurring human carcinogen, bis-furanocumarin that is found in aflatoxin. Aflatoxins are known contaminants on corn, peanuts, tree nuts, cottonseed and certain meats and hypoallergenic milks. Aflatoxins has also be isolated from ***A.nomius, A.niger*** . Certain animals (e.g., cattle, pigs), and birds (i.e., turkeys) are known to be more susceptible to this toxin than others. The U.S. Food and Drug Administration has set Action Levels for Aflatoxin. See the Table 1 below for more information. The toxicity of aflatoxin varies considerably with regards to age, and nutrition. Sheep are very resistant to poisoning by aflatoxin (1) .

Table 1: U.S. Food and Drug Administration (GIPSA): Aflatoxin Action Levels (2)

	Crop	Host	Action Levels
			(Parts per billion)
A	Milk	Human	0.5
B	All Product, except milk	Human	20
C	Feed		
1	Corn & Grain	Immature Animals/ Poultry/Diary Animals	20
2	Except Corn & Cottonseed Meal	Immature Animals/ Poultry/Diary Animals	20
3	Corn & Other Grains	Beef, Breeding Swine, or Mature Poultry	100
4	Corn & Other Grains	Finishing (feedlot) Swine (>100 pounds)	200
5	Corn & Other Grains	Finishing (feedlot) beef cattle	300
6	Cottonseed Meal	Beef, Swine, or Poultry	300

Aflatoxin combines with the host deoxyribonucleic acids (DNA) to change the structure of the DNA by modifying the NADPH-dependent enzyme to inhibit the binding with the cytochrome P450 thus causing the suppression of ribonucleic acid (RNA) synthesis and ultimately protein synthesis. Aflatoxin is removed quickly from the blood stream through the bile duct at a rate of 65% in 90 minutes. The half-life was determined to be 13 minutes in humans.

The information was developed by A.Jin, LLNL, 21May 2003.

II. Hazards and Risks

The primary target organ is the liver causing tumors in mice, rats, fish, ducks, marmosets, tree shrews, and monkeys. Renal damage has been reported in animals but not in humans. Aflatoxin has been shown to effect the immune response of animals, effect bone marrow as an anti-coagulant, cause reproductive hazard in animal, mutagenicity of human liver cells, and have an association with Reye's Syndrome.

Aflatoxin in low concentrations is a highly effective carcinogen that targets the liver and in higher concentrations will cause kidney cancer. Although the literature states that there does not seem to be any direct dose response relationship to aflatoxin toxicity, studies indicate that human ingestion of:

- 1.5 milligrams/Kg will cause nausea, headaches, and rash.
- 2-6 milligrams/Kg induces epidemic proportions that may result in about 100 deaths.

Many types of aflatoxins have been isolated from many different sources (e.g., breast milk, soil, urine, tobacco). Based on fluorescence under ultra-violet light, some of the aflatoxins have been classified as "B" for blue fluorescence, or "G" for green fluorescence. See the table below for more information regarding the different types of aflatoxins isolated. In 1998, the International Agency for Research on Cancer (IARC) placed aflatoxin B1 on the list of human carcinogens.

Table 2: Characteristics of Aflatoxins from Aspergillus flavus [3]

	Types	Fluorescence	Source	Toxicity	LD 50
					(ug/kg)
	B or B1	Blue	*	Human Carcinogen	9,500
	B1 w/ G1	Blue		Toxic	68
	B2 dihydro B1	Blue	*	Most toxic	1,700 Duck: oral
	B3	Glue		Toxic	
	G1: Binds DNA	Green	*	Toxic	14,900 Rat: IP 785 Duck: oral
	G2 dihydro G1	Green	*	Toxic	2,450 Duck oral
	M1 4-hydroxyB1	None	Milk	Not Potent	320
	M2 4-hydroxyB2	None	Milk	Not Potent	281
	P1	None	Urine	Toxic	150
	Q1			Toxic	<0.10
	R0			Toxic	No Data
	T2	None	Tobacco	Toxic	No Data

(*) - Most Commonly found ubiquitously in nature.

Exposure to the aflatoxin occurs by slow skin absorption or by ingestion. Over a long period of time, ingestion of aflatoxin leads to the development of liver damage, necrosis, cholestasis, and hepatomas. The risk of systemic toxicity resulting form dermal exposure increases with the presence of high concentrations, occlusion and vehicles (i.e., surfactants) that enhances penetration.

Documents from USAMRIID [4] and the Defense Intelligence Agency[5] have determined that Aflatoxin would not make an effective biological agent. As seen in Table 3, approximately 8,000,000 kilograms (8,000 metric tons) of aflatoxin would be required to exposure a 100 square kilometer area under ideal meteorological conditions.

Table 3:

Quantity of Biological or Chemical Agent Required for a 100 Sq Foot Area [4][5]

	Type	Agent (Disease)	Quantity Required
			(Kilograms)
1	Biological Agent	Francisella tularensis (Tularemia)	0.2
2	Biological Agent	Bacillus anthracis (Anthrax)	0.2
3	Biological Material	Botulinum Toxin	8.0
4	Biological Material	Ricin	8,000
5	Biological Material	Aflatoxin	8,000,000 (8,000 Metric Tons)
6	Chemical Agent	Sarin	100,000 (100 Metric Tons)

III. Recommendations

It is important for all personnel to know the potential modes of transmission, use proper precautions such as those listed below when working or handling such materials. The following work practices may be more or less conservative than those practiced at other facilities.

Work Practices:

- General Work Practices: A Biosafety Level 1 containment level using biosafety level 1 work practices are required for handling, and use of non-aerosolize concentrations of research amount (less than 10 liters [6]. Aflatoxin is not a select agent as defined by U.S. 42 Code of Federal Regulations 73.4, and U.S. Department of Agriculture regulation: 9 Code of Federal Regulation 121.3 [7][8].

- ***Medical Surveillance***: Elevation of serum alkaline phosphatase in the blood is a good indicator of aflatoxin toxicity. Acute and convalescent samples should be drawn immediately after an incident to determine if exposure had occurred. Treatments with vitamin A have should to inhibit aflatoxin induced DNA adduct formation.

- ***Decontamination***: Numerous strategies involving physical separation, thermal inactivation, irradiation, solvent extraction, adsorption, microbial inactivation and fermentation have been proposed to detoxify or decontaminate this toxin. Surface washing with soap and water can dilute the concentration of toxin present. Aflatoxins are destroyed at high pH that hydrolyses the lactose ring to form a less toxic compound. The basic systems that have been successfully employed are [9]:

    - ***Sodium hypo chlorite/ followed by an Acetone wash (Lab Waste)***
    - ***Ammonia (animal feed and litter)***
    - ***Quicklime (animal carcasses)***
    - ***Potassium permanganate under acid conditions (Lab Waste)***
    - ***Incineration***

Personal Protective Equipment

- Use of gloves is highly recommended. Glove selection will be based on the chemicals used in conjunction with the aflatoxin.

Engineering Controls

- Use of a glove box is recommended when handling dry powders due to the electrostatic nature of the toxin.

References

1. TOMES ® Medical Management. Microdex 1987-1997. Vol 32.
2. US Dept of Agriculture: Grain Inspection Packers and Stockyards Administration. Aflatoxin Fact Sheet, September 17, 1998. (http://www.usda.gov/gipsa/newsroom/baclgrounders/b-aflztox.htm)
3. Sigma Aldrich Chemical Company, MSDS Sheets
4. Franz, COL David R., "Defense Against Toxin Weapons," "Medical Aspects of Chemical and Biological Warfare," Eds. Frederick R. Sidell, COL Ernest T. Takafuji, and COL David R. Franz, "Part I, Warfare, Weapons, and the Casualty,"
5. Textbook of Military Medicine: Medical Aspects of Chemical and Biological Warfare, Eds. BG Russ Zajtchuk and COL Ronald F. Bellamy, Office of the Surgeon General, Walter Reed Army Medical Center, Washington, DC, 1997, p. 606.

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6. ***Biosafety in Microbiological and Biomedical Laboratories.*** U.S. Department of Health and Human Services. Public Health Service, Centers for Disease Control and Prevention ***and*** National Institutes of Health. Fourth Edition, April 1999.

7. United States Code of Federal Regulations Volume 42. Section 73: ***Possession, Use, and Transfer of Select Agents*** (for Humans).

8. United States Code of Federal Regulations. Volume 7 Section 221: ***Possession, Use and Transfer of Select Agents*** (for Animals).

9. International Agency for Research on Cancer: Laboratory Decontamination and Destruction of Aflatoxins B1, B2, G1 and G2 in Laboratory Wastes. IARC Publication #37. 1980

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